

INSPIRE Tier 3

Kennedy Space Center

Lunar Regolith Excavation Competition

Liles, Cassandra

June 23, 2009

Reviewed by:

Robert Mueller

HQ 3488C KT-C-H1

A handwritten signature in black ink, appearing to read "Robert Mueller", is written over a horizontal line.

Liles, Cassandra

Lunar Regolith Excavation Competition

NASA/INSPIRE

Kennedy Space Center

Rob Mueller

June 8th – July 31st

The Lunar Regolith Excavation Competition is a new competition that needs graphics, logos, rules, as well as an arena. Although this is the first year of the competition, the competition is modeled after an existing competition, the Centennial Lunar Excavator Challenge. This competition however is aimed at college students. This makes the challenge identifying key aspects of the original competition and modeling them to fit into an easier task, and creating exciting advertisement that helps encourage participation. By using a youth focus group, young insight, as well as guiding advice from experts in the field, hopefully an arena can be designed and built, rules can be molded and created to fit, and alluring graphics can be printed to bring about a successful first year of the Lunar Regolith Excavation Competition.

The first task is to identify the resources available to use, mainly space and funding. Then start a rudimentary design of an arena. The plan is to use 80/20 to build a rough skeleton of the arena, and then line it with plywood, painted and decorated to make an attractive arena. The arena must then be filled with GRC-3 lunar simulant and compacted. The building however is the secondary task. First a clear design of where to place obstacles, how to compact the sand, and how to make the arena sturdy and highly portable. Then there is the task of graphic design. It is important to use already iconic images, to create something captivating yet symbolic of the goal. This is best accomplished by working with a team of graphic artists, and pooling ideas to come up with a permanent logo.

Data at this point is fairly limited. The current size of the arena is estimated to be about 4 meters by 7.5 meters and 1 meter deep. The sand collector bin is going to be modeled to emulate the actual lunar receptacle. Due to the quantity of simulant a forklift must be used to transport it. The graphic component of the project has yet to be started.

Contributing Parties: Rob Mueller, Susan Sawyer, Gloria Murphy, Greg Galloway, Julia Nething, Chris Le

Cassandra Liles

Kennedy Space Center

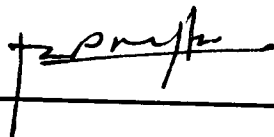
July 27th, 2009

Reviewed By:

Robert Mueller

Lunar Surface Systems

KT-C-H1

A handwritten signature in black ink, appearing to read 'R Mueller', is written over a horizontal line.

(Signature)

Liles, Cassandra
Lunar Surface Systems
Kennedy Space Center
Mentor: Robert Mueller
KT-C-H1
June 8th – July 30th

Forty Years ago, America put a man on the moon. It was an alien landscape, miles of a grayish white sand, riddled with rocks, and the new sight of the Earth rising over the moon like the sun over the horizon. The lunar surface was the new frontier for man, and in many ways, it still is. The Apollo astronauts collected samples, but these were only small quantities of a precious resource. As man prepares to go to the moon, and stay, the surface they plan on surviving on presents a myriad of unique problems. The soil is very abrasive; the astronauts that spent just a short time on the surface experienced respiratory difficulties from the fine particles that would get into their breathing air. It destroyed the fibers of their space suits, patches, and instruments. While the soil is abrasive, it is also oxygen rich, making it possible to extract air from the lunar environment. The Lunar Surface Systems division focuses on all of the problems and needs found on Earth's moon, with hopes of once again, letting man stretch his arms out into space, as the next great frontier.

My internship here at Kennedy Space Center has allowed me a glimpse into the difficulties the lunar system presents. It has been instructional on how harsh the lunar surface can be, but inspirational by explaining how human technology plans to overcome these obstacles. I have gotten to work with the scientists designing the up and coming lunar rovers, the oxygen extraction devices, as well as the people working to simply move the lunar soil, regolith, efficiently. Because there are only limited quantities of actual regolith available to researchers, various NASA space centers have created substances to simulate the regolith properties.

Regolith is mostly very tiny particles, these small particles compact creating very dense materials. It is also very rich in oxygen, which can be extracted through melting the soil, allowing the oxygen to become gaseous and escape, which can be further processed. Since all of these problems need to be ready to go at the same time, these projects are all running parallel to each other. As an intern, I have been invited to watch different manners of simulant movement, compacting, testing, flow rates, and sit in on design meetings for oxygen extraction.

But my internship has also been much more hands on. I have been placed on a team consisting of two other interns, Christopher Le, and Julia Nething, to create a Lunar Regolith Mining competition, named Lunabotics. Lunabotics is modeled after the Centennial Challenge, but scaled down to be more accessible to students. The playing field is larger, 7.5m x 4m x 1 m, than the centennial's 4m x 4m box. Instead of a single 30 minute round, it is a set of 15 minute rounds, allowing the competition to be more upbeat and youth focused. The Lunabotics also introduces some unique challenges to the competitors. There are two robots on the field, there is an obstacle area, and each round changes the point value. This requires the student drivers, as well as the robot itself to be flexible maneuvering the dynamic field.

This competition was not simply handed to us, it started as a task. We were asked to design a younger version of the centennial challenge, everything from graphics to rules, it needed to be difficult but engaging. This competition was not about getting new space aged hardware from corporations, but getting students excited about NASA's trip back to the moon. We started off with a few contact numbers, a place that our arena needed to fit, and a wonderful mentor that was available to answer our questions. The very first issue we faced was the simulant, how is 30

tons of dirt going to be put in the box, and then removed? We spent hours brainstorming this event until our question was finally answered with, the sand will all be moved by heavy duty equipment, and we need to move on to a more difficult task. The space we had dictated the parameters for how large our arena could be. But as we did a volume / density comparison, our maximum space would be too big for the amount of sand we had, so we reduced the size to get the perfect depth (roughly .6m). While initially we were thinking of having a square arena, we decided to change that to allow all of the competitive advantages of a rectangular field. The rectangular field allows for an obstacle area that must be conquered by each team. But as we started hammering out the details of the space dedicated to obstacles, we had to consider the time of preparing the field for each play. A single 15 minute round for one robot requires 5 minutes of putting the robot on the field, 15 minutes of digging, 5 minutes of taking it off the field, and 10 minutes to prepare the field for the next match. That is 35 minutes per round, each team getting two rounds, That is 70 minutes per team just for the qualifying round, if we had 10 teams, we would never be able to finish the competition. So then the thought came of having two robots, it goes twice as fast, and there is another edgy angle. Not only do the competitors have to go dig to get the simulant, they have to dodge the holes the other robots created. These ideas came from hours of meetings, brainstorming, and doodling on a white board waiting to be inspired by our muse. On top of coming up with the ideas of how to do it, we needed to express our ideas so we could communicate them to others. We learned Pro-Engineering, and Math CAD, so we could have clear precise data to present. We have great faith that our competition will be attractive to universities, and their students.

We had another side project to work on. There is a device named the Quick Attach that is being designed for the Chariot rover. While we do have a prototype of the quick attach, we do not have a Chariot rover to test it on base. However, we have a HumV with room for attachments. We were given the project to take the HumV, measure it's frame attachments, and find a way to attach the Quick Attach to the vehicle. This required measuring the HumV, getting CAD models of the quick attach, and designing an interface plate. The plate is a piece of aluminum, that fits the HumV attachments, as well as the Quick Attach, allowing our team to test the Quick Attach quickly and without flying to Texas to use the Chariot rover prototype. It was exciting to get to use Pro-Engineering, a wildfire software, to insert measurements, and creatively shape a plate, and invent attachments, for a smooth and solid connection. During our summer we did not get to see the plate built, we have been told it will be built shortly after our departure.

While we only had those two projects, we were invited to many exciting events. We were allowed to tour the Vehicle Assembly Building, VAB, to review shuttle launch film. We were allowed to participate in the discussions about the foam falling, and how critical the different pieces may be. We were allowed to watch the new Ares-I-X rocket being assembled. We got to do the inspection of the Solid Rocket Boosters, SRB's that were retrieved after the shuttle launch. We learned about the different sections, how they are built, the fuel that goes into them, and what to check for with damages. We toured the International Space Station Processing Facility, SSPF, being allowed to see everything from the racks, lockers, and tethers for the astronauts, to the modules and research units going into space. We got to watch the LRO/LCROSS launch as it blasted off to the moon to create a detailed map, and search for

water. We got to watch the astronauts load into the Astrovan while riding out to go into orbit, two different times before they finally got the all's clear and were allowed to launch. We watched one of the final Shuttle launches, as Kibo, Crew, and the Orbiter Endeavor made their way to the Space Station.

The best part of our internship was not just what we were allowed to do, but what we were invited to be a part of. As an intern at Kennedy Space Center, you get to be a part of the design meetings, a part of the process, a part of the NASA family. Getting to make a difference in the development of man going to the moon, mars, and beyond was an experience that goes unrivaled. It is more than just about learning, or watching, it is about joining a team, making decisions, and making a difference. Thanks to Robert Mueller, Greg Galloway, Michelle Amos, Janis Palin, Ivan Townsend, Jim Mantovani, Susan Sawyer, Gloria Murphy, Mandy Falconer, Zach Lance, Lucas Lance, Christine Elliot, Alex Green, and everyone else that has supported the creativity and success of my internship.